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Functional evaluation of a modified Studer ileal neobladder



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Abstract

Objectives: To evaluate the results of using a shorter ileal segment (40 cm only) in reconstructing Studer ileal neobladder after radical cystectomy.

Subjects and methods: Radical cystectomy and modified Studer ileal neobladder was performed in 60 patients for invasive bladder cancer. Only 40 cm of the ileum was used; 32 cm segment for constructing the body of the neobladder, while the remaining 8 cm as an isoperistaltic intact limb for ureteral reimplantation. After one year, evaluation included clinical, laboratory, radiographic and urodynamic studies to determine the functional and oncological outcomes.

Results: Early complications occurred in 5 patients (8.6%). According to the modified Clavien system, two patients had grade I complications, IIIb occurred in one patient and two patients had grade V complications. Late complications (8.6%) included incisional hernia in 2 patients, deep venous thrombosis, bilateral uretero-ileal anastomotic stricture and intestinal obstruction each occurred in one patient. At one year, daytime and nighttime continence was 93.1% and 89.7%, respectively. Reflux was observed in 6 patients (10.3%) which was unilateral in 3 patients and bilateral in 3 without affecting the renal functions. Neobladder pressure was 7–18 cmH₂O at half capacity and 13–38 cmH₂O at full capacity with no uninhibited contractions.

Conclusion: Minimizing the length of the ileum for Studer neobladder reconstruction is feasible and with acceptable results.

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Introduction

The orthotopic neobladder represents an important evolution in the field of urinary diversion. It is now the preferred diversion after cystectomy and is superior to all other types of diversion in terms of better quality of life (QoL) [1]. Studer neobladder is one of the most commonly used techniques, originally utilizing 60–65 cm of the ileum in reconstructing this neobladder [2–4]. Using a longer ileal segment (e.g. 60 cm) may be advantageous in obtaining an early large neobladder capacity and better continence. However, this may lead to the formation of a flaccid reservoir with an increased risk of chronically infected residual urine and increased incidence of clean intermittent catheterization (CIC) on the long term [5]. In this study, we used only 40 cm of the ileum to reconstruct the neobladder in a new way. We divided the ileum into 32 cm for the reservoir and 8 cm segment left intact as an isoperistaltic limb for ureteral reimplantation. The use of a 40 cm segment is not new for neobladder reconstruction, but it is the first time to be used in this way for Studer neobladder reconstruction [1]. Our hypothesis is; the functional and metabolic outcomes using this short ileal segment for pouch reconstruction will be acceptable, as the initial small capacity of the reservoir will increase with time.

Subjects and methods

Sixty patients, including two females, with muscle invasive bladder cancer (MIBC) were enrolled in this prospective study between January 2011 and January 2014. This study was approved by the local ethical committee.

Inclusion criteria

- 1- Patients with muscle invasive bladder cancer ($T_{2-3}N_{0-1}M_0$).
- 2- No cancerous involvement of the bladder neck area including the trigone.
- 3- Medically fit, motivated patients accepting the operation.

Exclusion criteria

- 1- Impaired renal function (Serum creatinine ≥ 1.8 mg/dl)
- 2- Previous bowel resection, severe diverticulosis or inflammatory bowel disease
- 3- Inability to do self-catheterization due to physical or mental impairment
- 4- History of voiding dysfunctions that denotes sphincteric or urethral stricture disease
- 5- Positive prostatic urethral biopsy

Preoperative evaluation and care

After careful clinical history and physical examination, abdomino-pelvic ultrasonography, enhanced abdomino-pelvic CT scanning, complete laboratory work up and physical fitness were performed. TUR biopsy of the bladder tumor and the posterior urethra in males was done followed by examination for bladder mobility under anesthesia. Adequate counseling of all patients with a written informed consent was obtained before surgical intervention. In our center, oral fluids and intestinal antiseptics (oral neomycin and metronidazole) were given one day prior to surgery and 2 enemas were given the evening before surgery to decrease the incidence of infectious complications as stated by some authors [6,7], although bowel preparations may be omitted in most centers. Oral fluids were

stopped 6 h prior to surgery. Patients were given IV third generation cephalosporin and metronidazole after induction of anesthesia and before skin incision.

Operative technique

Standard radical cystectomy (RC) with bilateral lymphadenectomy was performed followed by creation of the ileal neobladder in a cross folded U configuration (Goodwin cup-patch principle) as described by Studer [2]. But, we used only 40 cm segment of the ileum, 25 cm proximal to the ileocecal valve. We divided this segment in a special way; the distal 32-cm as the body of the reservoir, the remaining proximal 8 cm segment was left as an intact limb (chimney) for ureteral reimplantation. A direct end to side uretero-intestinal anastomosis to the isoperistaltic limb (Nesbit's technique) was done. After complete closure of the neobladder, the pouch was filled with saline to ensure water tight closure, determine the intraoperative capacity and ensure patency of both the urethral catheter and the pouchostomy tube. After securing the hemostasis, tubal drains were placed one on each side of the pouch brought through a separate incision of the abdominal wall. Anatomical closure of the abdominal incision and securing the catheters to the abdominal wall were done to conclude the operation.

Postoperative care

Parenteral alimentation was maintained for 3 days, followed by 3 days on oral fluids, then the patient was allowed to consume semisolids for another 3 days. Antibiotics were administered according to the postoperative course. Tubal drains were removed once fluid drainage has ceased. Ureteric stents were removed 10–12 days postoperatively, followed by removal of the suprapubic tube 2 days later. The urethral catheter was left for 3 weeks. After catheter removal, patients were taught how to void and perform regular pelvic floor exercises to improve the continence status. They were told to empty the neobladder initially every 2 h in a sitting position by relaxing their pelvic floor ended by slightly increasing their intra-abdominal pressure. Subsequently, three to four hourly voids were encouraged. Abdominal US was performed just before discharge to determine the pouch capacity and post voiding residue (PVR). Oral sodium bicarbonate substitution was administered for 3 months postoperatively to decrease the incidence of metabolic acidosis [2].

Follow-up visits were scheduled every month for 6 months and every 3 months thereafter. It includes physical examination and assessment of the continence status. Patients were considered continent if they were completely dry during follow-up and did not use pads. Laboratory evaluation in the form of urine analysis and/or urine culture, serum creatinine, serum electrolytes and acid base profile were performed each visit. Abdominal US was performed each visit to assess the prescence of pelvicalyceal dilation, parenchymal echogenicity, capacity of the neobladder and PVR. Abdomino-pelvic CT scanning was done after 3 and 12 months postoperatively to exclude UUT obstruction or recurrence of malignancy. Voiding poucho-urethrography to assess the prescence of reflux, and urodynamic evaluation of the pouch capacity and filling pressure were performed after one year. Filling was maintained for both poucho-urethrography and urodynamic evaluation till the patient reported a sensation of lower abdominal heaviness which is the same that urges the patient to void.

Results

The age range was 41–67 years (median 57 years). The mean operative time for the procedure was 5.1 ± 1.2 h. The mean estimated blood loss was 800 ± 180 cc, with the need to intraoperative blood transfusion were present in 35 patients (58.3%).

The preoperative histopathology was; transitional cell carcinoma in 39 patients (65%), squamous cell carcinoma in 16 patients (26.7%) and adenocarcinoma in 5 patients (8.3%). Grades of the tumors were: well differentiated in 16 patients (26.7%); SCC in 14 and adenocarcinoma in 2 patients, respectively. Grade II (moderately differentiated) was present in 20 patients (33.3%); SCC *in situ* 2, adenocarcinoma in 3 and TCC in 15 patients. Grade III TCC was found in 24 patients (40%). Associated carcinoma in situ was present in 8 cases (13.3%). Ten patients received neoadjuvant chemotherapy (16.7%); 6 patients due to enlarged lymph nodes and 4 due to stage T3b on the preoperative imaging studies.

Histopathologic examination of the postoperative specimens showed that the surgical margin was free of malignancy in 58 patients (96.7%) and positive in two patients (3.3%). The number of retrieved lymph nodes/case ranged from 8 to 25 (17.7 ± 5.5). Reactive hyperplasia was detected in 56 patients (93.3%) and malignant involvement in four patients (6.7%). Grade shift from moderately to poorly differentiated SCC in 2 patients and from grade II to III in 11 patients with TCC was found.

Hospital stay lasted for 21 days in 57/60 patients till removal of the urethral catheter as the majority of our patients were from far rural areas where the availability of healthcare for this kind of advanced surgery is difficult to be obtained. One patient developed poucho-intestinal fistula 7 days after the operation that was discharging its contents through the urethral catheter and the suprapubic tube but not the drains. It was treated conservatively using somatostatin, but the output of the fistula did not decrease for 13 days. The patient was in a good general condition with no intra-abdominal sepsis and had normal laboratory investigations (including the albumin level). Exploration was done, the site of intestinal anastomosis was adherent to the suture line of the pouch. Surgical repair by primary excision of the fistulous tract and closure of both ends with omental interposition was done. The patient was discharged 10 days after the repair. The other patient developed poucho-cutaneous fistula, burst

abdomen and multi-organ failure, so he stayed for about 2 months, then died of his complications. The third patient died on the 7th post-operative day due to brain stem infarction and respiratory failure.

At one year, complete daytime continence was achieved in 54 patients (93.1%). The remaining 4 patients (6.9%) suffered from stress urinary incontinence (SUI). Complete nighttime continence at one year was achieved in 52 patients (89.7%). Six patients (10.3%) had nocturnal enuresis.

After one-year, there was no reflux in 52 patients (89.8%), 6 patients (10.3%) had reflux (3 unilateral and 3 bilateral) (Figs. 1 and 2). Uretero-ileal anastomotic obstruction occurred in one patient. It was bilateral and associated with impaired renal function (serum creatinine 5 mg/dl), for whom bilateral percutaneous nephrostomy were applied.

The mean intraoperative pouch capacity was 148 ± 35 ml without a significant change when measured after the catheter removal before discharge. Neobladder capacity was 332 ± 59 ml at 6 months and 583 ± 137 ml at one year. PVR at one year was 34.20 ± 6.69 ml. There was no need for clean intermittent self-catheterization (CIC) during the study as PVR was minimized by double and triple voiding. Complete urodynamic evaluation after one year showed that, the resting intra-pouch pressure was 12.41 ± 3.31 cmH₂O at half capacity and 25.08 ± 6.64 cmH₂O at full capacity. No uninhibited contractions were reported. None of the patients – even those who reportedly had SUI – leaked during filling. The maximum flow rate (Q_{max}) was 15.42 ± 4.69 ml/s.

Serum creatinine was less than 1.4 mg/dl preoperatively in all patients. Postoperatively, it remained within the normal values during the study except the patient with bilateral uretero-enteric stricture as previously mentioned. Urine cytology was negative in all patients at 3, 6 and 12 months after surgery. Urine culture was negative in 45 patients (77.6%). Positive urine culture was found in 13 patients (22.4%). The most common organism was *Escherichia coli* (45%). No treatment was given except for symptomatic patients. Two patients (3.4%) developed metabolic acidosis, after 6 and 8 months postoperatively. They were managed by immediate IV sodium bicarbonate administration with oral sodium bicarbonate maintenance for 6 weeks. Notably, this occurred in absence of chronic retention or reflux and did not recur after treatment.

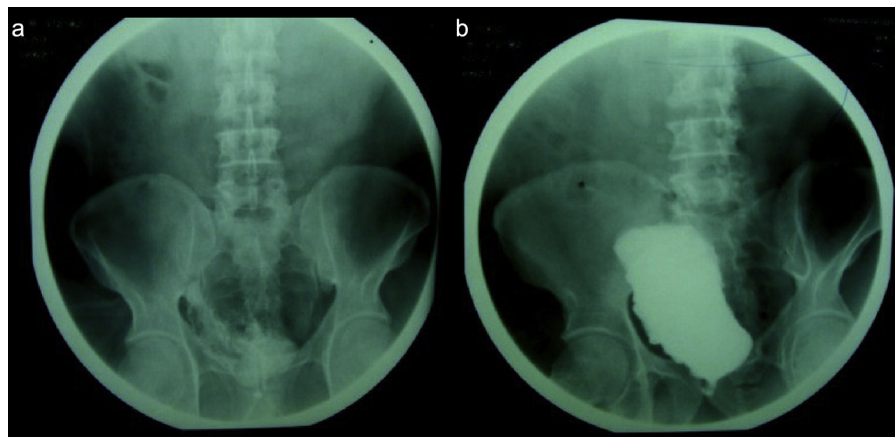


Figure 1 Ascending urethro-pouchogram with voiding study of a patient with a modified Studer neobladder after 1-year showing the configuration of the pouch (a), with minimal PVR and absence of reflux (b).

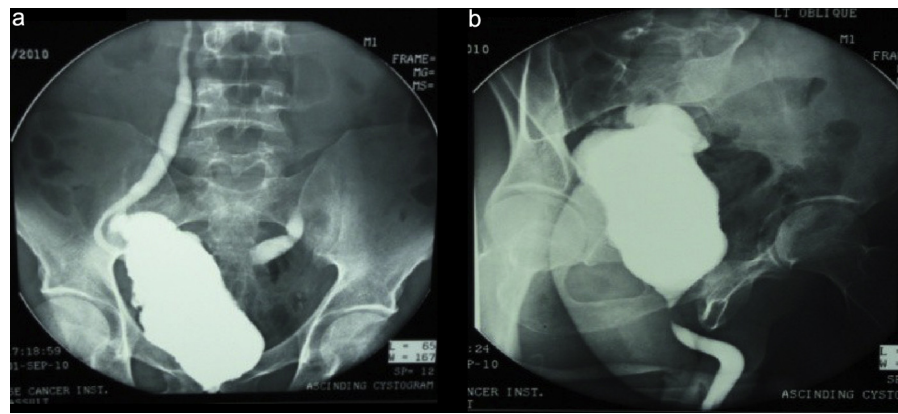


Figure 2 Ascending urethro-pouchogram of another patient with a modified Studer neobladder at one year postoperatively showing the configuration of the pouch (a), with bilateral poucho-ureteral reflux (b).

Table 1 Postoperative complications.

	Grade	Type	Number	Percentage %
<i>Early postoperative complications</i>	I	Slipped urethral catheter	1	1.7%
	I	Persistent urine leakage	1	1.7%
	IIIb	Poucho-enteric fistula	1	1.7%
	V	Brain stem infarction, respiratory failure, death	1	1.7%
	V	Multi-organ failure, burst abdomen, failure of pouch healing, death	1	1.7%
<i>Delayed postoperative complications</i>		Incisional hernia	2	3.4%
		Deep venous thrombosis	1	1.7%
		Intestinal obstruction	1	1.7%
		Bilateral uretero-ileal stricture	1	1.7%

Recurrence of malignancy occurred in 7 patients (12.1%). It was pelvic recurrence in 4 patients. Hepatic, colonic and bone metastasis each occurred in one patient. Postoperative histopathology in those patients was: high grade TCC in 4, moderately differentiated SCC in 1 and poorly differentiated SCC in 2 patients. Four mortalities occurred; they were due to tumor recurrence, all of them occurred after the first year.

Postoperative complications were classified as early and late complications. They are listed in Table 1.

Discussion

The orthotopic neobladder substitution (OBS) is the diversion of choice after RC and superior to all other forms of diversion in terms of better QoL [1]. Studer technique is a well-known technique of urinary diversion and several series have promoted it over the others [8].

The original Studer neobladder uses 60–65 cm segment of terminal ileum. The distal 40–45 cm segment serves as the reservoir, whereas the proximal 20–25 cm segment remains intact for ureteral implantation and prevention of reflux by isoperistaltic waves. The uretero-intestinal anastomosis is performed with an end to side technique at the proximal end (Nesbit technique) [2].

In our study, we tested the notion that minimizing the length of the ileum used for pouch reconstruction can improve the voiding

pattern, decrease PVR and decrease the incidence of CIC while maintaining a good function of the UUT. This can also decrease the metabolic complications by decreasing the surface area available for reabsorption of urinary solutes. We used only 40 cm with our new way of division of the ileal segment; 32 cm for the reservoir and 8 cm for the isoperistaltic limb.

Our arguments for using a shorter ileal segment are based on the concept that constructing an initial small pouch capacity has been proven to be not harmful, increases with time to a continent, non-refluxing reservoir with no or a small PVR [4]. A shorter chimney seems appealing because reflux prevention – which necessity is controversial – does not depend solely on its length, hence this allows more preservation of the intestine, and the use of a longer segments of the lower ureters which participate in reflux prevention [1,2,9]. After OBS, voiding occurs by abdominal straining. The increased intra-abdominal pressure does not produce an isolated rise in the intra-reservoir pressure but acts equally on the chimney, ureters and renal pelves and decreases the incidence of reflux. In addition, with de-tubularised bowel segments, no co-ordinated contractions occur and therefore, no appreciable pressure is generated within the reservoir. If a major pressure peak occurs within the neobladder, the external sphincter will act as a safety valve; allowing urinary leakage and reflux prevention. Also, reflux nephropathy is unlikely to occur as the urine is usually enclosed within a sterile system of OBS [2].

One of the important factors that affect the continence after OBS is the size and configuration of the neobladder. The initial reservoir

after surgery is small and high-pressured and leakage during the early postoperative period may occur. Continence improves during the initial 6–12 months postoperatively as the size and compliance of the reservoir increases. Also, sphincter training will improve continence and aid gradual stretching of the reservoir wall [10,11].

We defined continent patients as those who reported themselves as continent during follow-up, and who did not use pads. At one year, daytime continence was achieved in 54 patients (93.1%). The remaining 4 cases (6.9%) suffered from SUI and needed some form of protection pads. Patients with SUI were advised to void every 2–3 h, moderate their fluid intake, and to regularly perform pelvic floor exercises with a notable improvement during follow-up as indicated by the decreased number of pads needed. Studer et al., 2006, reported day and nighttime continence after one year of 92% and 79% respectively, dividing patients into complete continence requiring no protective pads and incontinent requiring one or more pads/day [2].

Nighttime leakage is reported to be 20–50% after one-year postoperatively despite a well performed operation [12]. It resolves as the functional capacity of the neobladder increases. Nighttime continence is achieved with improvement of the patient's voiding pattern [13]. In our study, nighttime continence was achieved at one year in 52 patients (89.7%). Patients with enuresis were advised to decrease their fluid intake at night, to void before going to sleep, and to awake with assistance of alarm clock to void once or twice during the night.

To use anti-reflux technique or not is debated [14]. Those against anti-reflux techniques reported that it increases the risk of anastomotic stricture than in refluxing anastomosis and the presence of reflux does not significantly alter the renal function. Moreover, voiding after OBS is accomplished using Valsalva as previously mentioned and this decreases the incidence of reflux [15]. Also, Reflux did not occur in many direct anastomosis, as seen in a study of Florida pouch in which it was demonstrated only in 7% of ureters (23 out of 326) [16].

Studer et al., 1991, stated that a twenty centimeter isoperistaltic ileal segment can prevent reflux by transmission of the intra-abdominal pressure on this afferent segment during Valsalva maneuver [2]. Hautmann et al., reported that a freely refluxing, end to side ureteric anastomosis to the afferent limb of the orthotopic reservoir, has the lowest complication rate [15].

Despite the short length of the isoperistaltic limb we used, six patients (10.3%) had reflux (3 unilateral and 3 bilateral). Uretero-intestinal anastomotic stricture occurred in one patient after one year, which was bilateral and associated with impaired renal function, for which bilateral percutaneous nephrostomy were applied. Integrating the published results and ours, we believe that a freely refluxing ureteral anastomosis to this short isoperistaltic limb is feasible, safe and with no harmful effect on the renal function.

Other studies tackling this issue demonstrated the logic of having more reflux with a shorter chimney. Hollowell CM et al., reported their 4-year experience using only 8–12 cm chimney modification of the Hautmann neobladder. Uretero-intestinal anastomotic strictures were detected in 6% of 100 ureteral units [17]. Another study using only 5 cm chimney for Hautmann neobladder, at a mean follow-up of 29.5 months, there was no uretero-ileal anastomotic stricture.

Reflux was demonstrated in 8/22 renal units (36.4%). All patients had a normal UUT without evidence of obstruction [18].

Regarding the voiding function, reservoir capacity increased over time reaching about 500 ml. In a study evaluating the long-term outcome of Studer neobladder, functional capacity was maintained at 400–500 ml. However, two patients developed a capacity >1000 ml 5 years after the operation. There were no significant changes of Q_{\max} or PVR during the follow-up. The mean rates were maintained at 10–20 ml/s for Q_{\max} and <60 ml for PVR [19].

Urodynamic testing of OBS indicated a good resemblance to the native bladder [20,21]. It showed that the intra-reservoir pressure is correlated to the reservoir capacity: the smaller the pouch capacity the higher the pressure. Practically speaking the high filling pressure is not maintained for long time as it urges the patient to evacuate the pouch. Voiding is mostly brought about by increasing the intra-abdominal pressure. As this pressure is transmitted equally on the reservoir, chimney and ureters, thus the UUT is not at risk of this high pressure [15].

CIC after OBS is observed in 4–25% of males [11,22] and up to 53% of females [23–25]. Excessive reservoir volume is one of the possible factors [24–26]. There was no need for CIC during our relatively short follow-up period. This could be due to the shorter length of the bowel used for reservoir construction which allowed gradual increase of the neobladder capacity with subsequent reduction of PVR. Similar low rates have been noted by Elmajian [27]. However, Steven and Poulson reported that the prevalence of CIC increased from 15.4% at 6 months to 43.2% at 5 years [28].

The functional results of the original Studer neobladder and our modified technique were shown in Table 2.

In patients with locally advanced or node-positive disease, some studies concluded that; OBS could be used if patients were appropriately selected, motivated and fit. A study by Hautmann et al., included 357 men who underwent RC and OBS, 43 local recurrences (12%) occurred, of whom 36 had locally advanced disease (stage

Table 2 Comparison between the functional results of the original Studer neobladder and the modified technique.

	Original Studer [3] No = 482	Modified Studer No = 60
Daytime continence	92%	93.1%
Nighttime continence	79%	89.7%
Reflux	n.m	10.3%
Mean neobladder capacity (ml)	n.m	583 ± 137
Uretero-ileal stenosis	2.7%	1.7%
Q_{\max} (ml/s)	n.m	15.42 ± 4.69
Mean PVR (ml)	n.m	34.20 ± 6.69
Mean neobladder pressure cmH ₂ O	n.m	25.08 ± 6.64
The need for CIC	2.9%	–
Positive urine culture	10%	22.4%
Metabolic acidosis	6.2%	3.4%
Postoperative complication		
Early	12.7%	8.5%
Delayed	23.8%	8.5%

CIC, clean intermittent catheterization; n.m., not mentioned.

pT3a or greater or node-positive) on histological examination of the cystectomy specimen. Forty patients maintained good neobladder functions, and only one required neobladder removal due to occurrence of intestinal fistula [29]. Similar results have been reported by others [30,31]. In our study, we had 4 local recurrences, and those patients were proved to have positive LNs in the postoperative histopathologic assessment.

Limitations to our study include lack of comparison to another form of diversion or even to the same technique with the original ileal length used, and the short follow-up period.

Our preliminary results of using this shorter segment of the ileum to construct Studer neobladder, as shown in Table 2, provides good pouch capacity and continence, minimal PVR, good function of the UUT and less metabolic complications if compared to longer intestinal segments of older studies. Long term follow-up are needed for further assessment of this modification.

Ethical committee approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This article does not contain any studies with animals performed by any of the authors. Informed consent was obtained from all individual participants included in the study.

Conflict of interest

All authors declare that they have no conflict of interest.

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Authors' contributions

In the development of the article, Ahmed M. Moeen (moeen3@yahoo.com) played the pivotal role by endeavouring works related to practical part, data collection, and writing the manuscript. Principally, Diaa A. Hameed (diaa.hameed@hotmail.com) too participated in practical part and writing the manuscript. Rabea A. Gadelkareem (dr.rabeagad@yahoo.com) solely took care of statistical analysis. Salah Eldin S. Abdel-Hafez (salaheldeem.gaber@med.au.edu.eg) worked on analysis of the results. Yasser M. Abdelsalam (ymabdelsalam@hotmail.com) and Abdelfatah I. Ahmed (abdelfatah.gad@med.au.edu.eg) together completed the revision of the manuscript.

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Editorial comment

H. Abol-Enein MD, PhD

The primary objectives of continent urinary diversion is to obtain a low pressure compliant urinary reservoir which provide reliable continence, comfortable voiding frequency day and night as well as preservation of the upper urinary tract on the long term.

The authors performed an orthotopic ileal reservoir fashioned from a short segment of ileum using Studer configuration in 60 patients including two females.

It is well known that Dr. Studer developed his original isoperistaltic ileal chimney inter position between the ureters and the body of the reservoir in an attempt to prevent the reflux to the upper tract.

The chimney originally was fashioned to be of 20 cm long segment. This length was critical to provide an adequate damping effect as a transit to protect the upper tract from the pressure changes of the reservoirs. For the chimney to be long enough and straight, the ureters should be cut at a higher level leaving only short ureteric length close to the lower pole of the kidneys.

Currently there is no specific bowel preparation in patients who will be subjected to an ileal orthotopic bladder substitution. Intra operative mechanical irrigation of the isolated bowel segment is quite enough. Detubularization and double folding of the fashioned reservoir is the key of having a low pressure compliant system.

Such small bowel segment (40 cm) will have a minimal metabolic consequences, however two patients developed clinical metabolic acidosis necessitated hospital admission. We do not know how many of the remaining patients had subclinical acidosis as the authors did not mention in the results.

One observation is the incidence of involved positive lymph nodes was 6.7% in spite of having a good number of lymph nodes removed

(17 nodes) which is very low incidence if compared to 23% of the international incidence of positive nodes in invasive bladder cancer.

I have learned from three decade experience in bladder replacement that 40 cm segment will produce a capacity of 400 cc of urine at 3–6 months provided that the whole segment is utilized for construction of the reservoir, and there is no reflux to the upper tract, the facts which give the reservoir a sort of recycling to be a capacious mature pouch within a few months postoperatively. In the present technique they used pouch constructed from 32 cm, and the pouch is connected to a refluxing chimney, this would give a capacity of 320 ml or even less as the pouch will not recycled well due to the refluxing chimney.

The very low incidence of both early and late complications should be critically reviewed, as it does not match with many of the reported international series dealing with such surgery.

There is no explanation of the absence of reflux on ascending pouchogram except that the radiologist did not fill the pouch well and it is difficult to estimate the capacity by urodynamic being the reservoir, chimney and the uretero-calyseal system all are one room.

One year follow up is very short time to calculate the outcome, and the kidney function would not be affected early in the short follow up, use the serum creatinine as a marker for kidney function is a very crude method. It will not be affected except when a major loss of renal mass occurs.

It is wondering why the length of the chimney is 8 cm and not a little shorter or longer than this, and to which rational this length was determined.

We don't know how many of the patients had an episode of pyelonephritis, being a significant number of patients had positive urine culture. We do not know about the two female patients, or if urodynamic evaluation was reformed for all patients, and when the study was done during the period of follow up.

I expected that this cohort of patients may not need alkali therapy to avoid the metabolic acidosis, but the reader may understand that all patients were kept on sodium bicarbonate treatment.

Furthermore, the patients who developed oncological failure should be discarded from the functional evaluation and hence the incidence would be re-calculated among the evaluable patients.

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Rebuttal to Editorial Comments

We thank the editor for his valuable and important comments that reflect a wide and solid experience.

While Dr. Studer uses a 20 cm isoperistaltic ileal chimney and considered this length is critical to protect the upper tract from the pressure changes within the reservoirs, in the same time, as you kindly mentioned, the ureters will be transected at a higher level close to the lower pole of the kidneys in order to keep this chimney straight. These short ureters will lose the inherent antireflux properties of their lower parts as reported by **Buzelin JM** in 1993 who reported that the pressure in the lower part of the ureter is 20–30 cmH₂O. The bladder end filling pressure is 20 cmH₂O for an optimal cytometric capacity of 450 cm³ [1]. This pressure difference is a safety margin and will be abolished if the ureter is transected at high level. Consequently, could this chimney be shortened with acceptable results? This was one of our study questions, which we believe that it has been answered positively.

Although currently there is no specific bowel preparation in patients who will be subjected to an ileal orthotopic bladder substitution, it is still our practice to perform limited bowel preparation to guard against unexpected events that may necessitate intraoperative change of the plane, e.g. rectal injuries or using the sigmoid colon instead of the ileum.

Although we didn't encounter cases of subclinical acidosis in our study, which may be attributed the shorter bowel segment, two cases of manifested acidosis occurred and these have been commented upon in the results.

The incidence of positive lymph nodes in our study is lower than that reported in larger series as that of Ghoneim and Abol-Enein which may be explained by our smaller sample size [2].

The early postoperative capacity of the modified technique was small as expected, yet it increased to 332 ± 59 ml at 6 months and 583 ± 137 ml at one year which is a good capacity achieving a balance between guarding against reflux and not using CIC. This may be achieved by patients' adherence to regular voiding, gradually increasing the interval between voiding and performing regular pelvic floor exercises to improve the outlet resistance which allow stretching of the reservoir wall. The decreased PVR, good uroflometry and absence of CIC were preliminary encouraging outcomes.

The lower incidence of both early and late complications was mainly due to our smaller sample size if compared to other large series dealing with such surgery.

In our study, 6 patients (10.3%) had reflux. Our explanation of the reduced incidence of reflux- in addition to the timing of performing the study after one year which allows maturation of the pouch- is that during either the urodynamic testing or the ascending pouchography, filling was done till the patient felt lower abdominal heaviness similar to that urges him to void. So, there was no fixed volume infused, and we felt that there is no point in infusing more saline

after the patient felt the urge, as it would be a non-physiological condition.

The one year follow-up of our patients is short and is considered one of the limitations of our study as we mentioned in the conclusion. But, these results are preliminary and long-term evaluation of those patients will be done during which renography will be added for better assessment of the renal function not only the serum creatinine.

Our chimney was 8 cm long for these reasons;

- 1 First, for easy sizing of the neobladder. After harvesting a 40 cm ileal segment, this length was easily arranged into 5 equal 8 cm segments. Four segments were then used as the body of the reservoir and the last one as an isoperistaltic chimney for ureteral reimplantation.
- 2 Reflux prevention- which necessity is controversial- doesn't depend solely on the length of the chimney. After neobladder reconstruction, voiding occurs by abdominal straining. The increased intra-abdominal pressure does not produce an isolated rise in the intra-reservoir pressure, but acts equally on the chimney, ureters and renal pelves, hence decreases the incidence of reflux. In addition, with detubularised bowel, co-ordinated contractions will be abolished and therefore no appreciable pressure is generated within the reservoir. If a major pressure peak occurs within the neobladder, the external sphincter will act as a safety valve; allowing urinary leakage and reflux prevention. Also, reflux nephropathy is unlikely to occur as the urine is usually enclosed within a sterile system of OBS [3].
- 3 Hautmann modified his technique and uses two shorter chimneys of about 2-3 cm for ureteral reimplantation by Wallace technique with good results [4].

None of our patients even those who had positive urine culture developed pyelonephritis. This may be explained by keenness of patients to empty their neobladder regularly by double and tribble voiding as we advised them, the reduced PVR and appropriate antibiotic treatment.

Urodynamic evaluation was performed after one year for every patient included the two female patients as mentioned in the subjects and methods section.

Regarding the alkali therapy, oral sodium bicarbonate was administered only for 3 months postoperatively to decrease the incidence of metabolic acidosis [3]. The two patients (3.4%) who developed manifested acidosis were managed by immediate IV sodium bicarbonate administration with oral maintenance for 6 weeks only.

Patients who developed oncological failure were included in the functional evaluation because;

- 1 Our functional evaluation was done after one year. There were 7 oncological failures. Only two of them occurred late in the first year (and they were still evaluable for functional results) and the remaining occurred after that.

2 In a study by Hautmann et al, included 357 men who underwent radical cystectomy and orthotopic neobladder, 43 local failures (12%) occurred. He included them in the functional evaluation and concluded that 40/43 patients who developed oncological failure maintained good neobladder functions, and only one required neobladder removal due to occurrence of intestinal fistula [5]. Similar results have been reported by others as referenced in the manuscript [6,7].

WE thank the editor for his kind comments and for his time and experience that definitely made our work better.

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